

Platform Management IPMI Controllers, Sensors, and Tools

Tom Slaight

**Server Management Architect
Enterprise Platforms Group
Intel Corporation**

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Introduction

- **Audience:**
**Architects, Technical Managers,
Firmware Leads, and Hardware
Designers**
 - Involved in architecture, component selection, debug, test, or design of server baseboard and peripheral management subsystems
- **Focus: IPMI-based implementations**
 - Hardware components
 - Hardware and firmware development tools

Disclaimers

- **A good starting point**
 - ... but not a comprehensive list of vendors or available technology
 - Listing of particular vendors and products does not constitute an endorsement by Intel or the IPMI Promoters
- **No guarantees on accuracy of information provided**
 - Contact vendors directly for complete specifications and availability information

“Architect’s Pick”

Agenda

- **IPMI Update & Architecture Overview**
- **Baseboard Management & Enclosure/Peripheral Controllers**
- **Sensor Devices**
- **Putting it all together - design advice and tools**
- **Summary**



IPMI

Intelligent Platform Management Interface

- Defines a standardized, abstracted, message-based interface to intelligent platform management hardware
- Defines standardized records for describing platform management devices and their characteristics

Promoters:



Adopters: Over 125 and growing

<http://developer.intel.com/design/servers/ipmi>



Initiative News



The screenshot shows the Intel Developer website interface. At the top, there's a navigation bar with 'Products' and 'Support' buttons, and a search bar. Below this, a sidebar on the left lists various developer resources under the 'Developer' heading, including 'Hardware Design', 'Software Development', 'Download Software/Drivers', 'Design Support/Services', 'Events, Training & Pubs', and 'R&D/Initiatives'. The main content area features a large banner for 'Intelligent Platform Management Interface' (IPMI) with an image of a server and a globe. A large blue diagonal banner with yellow text is overlaid across the center, reading: 'Updated Errata, Conformance Test Suite and 64- & 32-bit .NET/Windows* 2000 Drivers Available'. Below this banner, there's a section titled 'New releases (as of 8/05/02):' which lists several updates, including 'IPMI v1.5 Conformance Test Suite (ICTS) Prototype 5.02'. At the bottom of the screenshot, a white box contains the URL 'developer.intel.com/design/servers/ipmi' in blue text.

Updated Errata, Conformance Test Suite and
64- & 32-bit .NET/Windows* 2000 Drivers Available

developer.intel.com/design/servers/ipmi

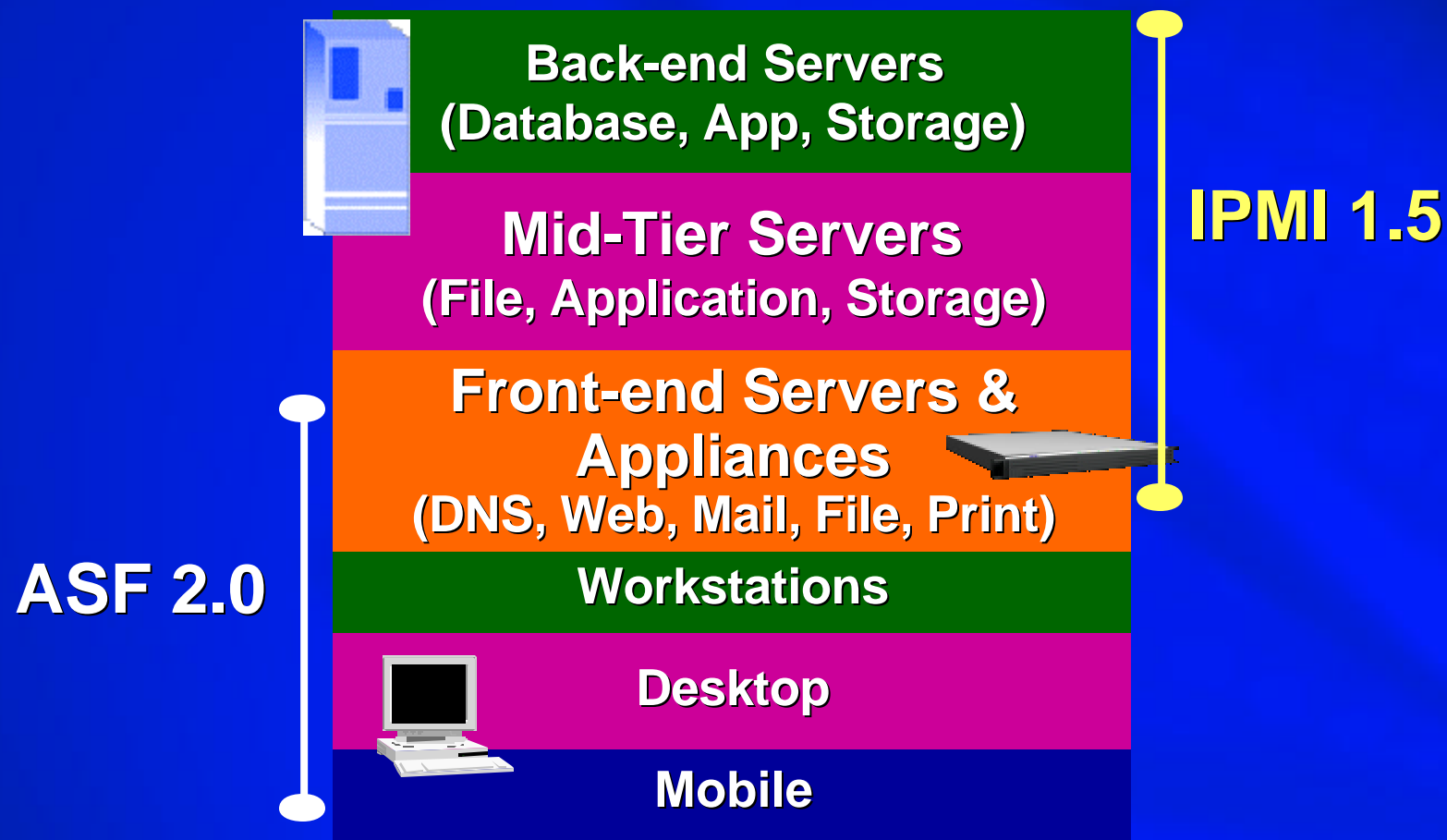


* Other names and brands may be claimed as the property of others.

Other Initiative News

- **ASF 2.0**
 - **A**lert **S**tandard **F**ormat specification from DMTF
 - Adds authentication to remote power and reset control over ASF 1.0
- **PICMG 3.x / AdvancedTCA***
 - IPMI additions for PICMG 3.x support
 - Network function for “AdvancedTCA” commands
 - Slot/Connector type for “AdvancedTCA” boards

ASF/IPMI Typical Applications



**IPMI and ASF are complementary
and cooperating technologies**

Platform Management Technologies

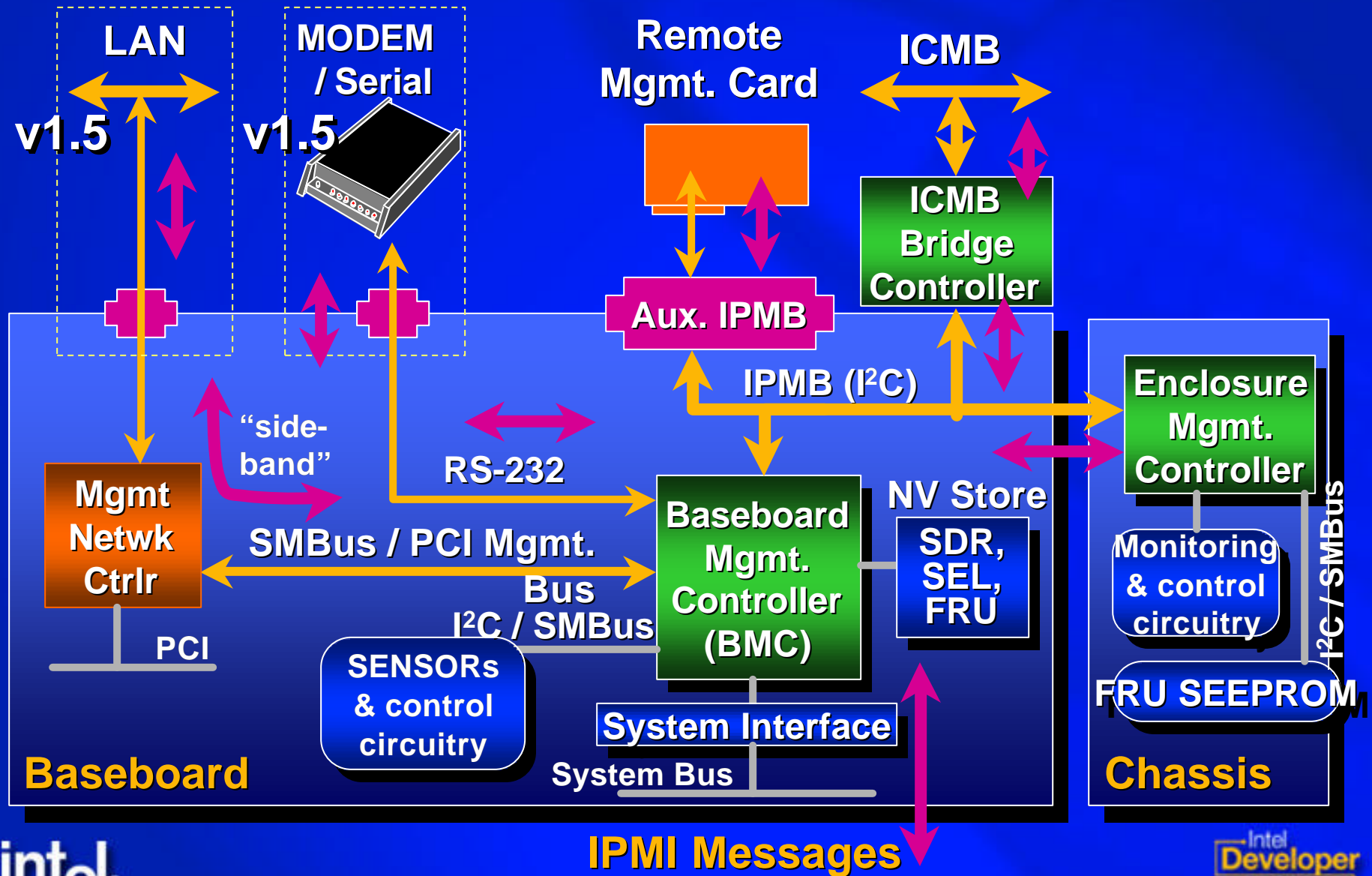
<div> <div>IPMI 1.5</div> <div>ASF 2.0</div> </div>	System Health & Security Alerts	<ul style="list-style-type: none"> • Health Alerts (Temperature, Voltage, Fan, etc. -- 128 definable alerts) • Security Alerts (Chassis Intrusion, LAN Heartbeat, System Password Violation) • BIOS Messages & Alerts • OS Hung Watchdog Timer
	Authenticated Remote Control**	<ul style="list-style-type: none"> • Processor Missing (startup Watchdog) • Power up/down/cycle/reset • Boot & Boot Path Options
	Status Info	<ul style="list-style-type: none"> • System State • System ASF Capabilities • Presence Ping/Pong
	Monitoring	<ul style="list-style-type: none"> • Abstracted Local and Remote Monitoring • Health Sensor "Present Reading" Access (Temperature, Voltage, Fan, etc.)
	Inventory and Logging	<ul style="list-style-type: none"> • FRU/Inventory Data Access • Event Logging
	Extended Out-of-Band Access	<ul style="list-style-type: none"> • Serial/Modem Access • Text-based Access • Inter-Chassis Access • Multi-level, Multi-user Security
	Extended Alerting	<ul style="list-style-type: none"> • Alerts to multiple destinations • Paging via Modem
	Automatic Actions	<ul style="list-style-type: none"> • Platform Event Filtering (PEF) - Configurable, Event-based automatic recovery & alerts
	Scalability / Extensibility	<ul style="list-style-type: none"> • Utilizes independent BMC • "Unlimited" Events & Sensors • Extensible Sensor/Event Busses



** IPMI supports multi-user as well as multilevel authentication

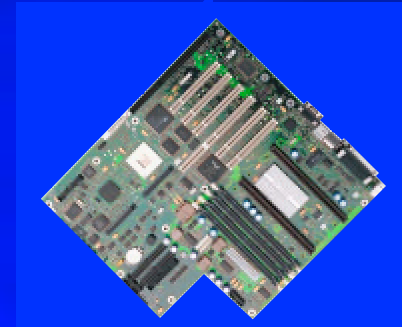


IPMI v1.5 Architecture



Agenda

- **IPMI Update & Architecture Overview**
- **Baseboard Management & Enclosure/Peripheral Controllers**
- **Sensor Devices**
- **Putting it all together – design advice and tools**
- **Summary**



System Interface

- **Built-in System Interfaces**
 - For IPMI, three types possible:
 - KCS (Keyboard Controller Style) most popular.
 - BT (Block Transfer) is fastest.
 - SMIC (Server Mgmt. Interface Chip) for implementation via external ASIC or FPGA [not recommended for new designs]
- **“Low glue” connection to chip set**
 - LPC or ISA “X-bus” interfaces commonly used
 - IPMI specifications support **memory mapped implementations** as well as original I/O mapped
- **System Interface interrupt support**
- **Multiple Built-in System Interfaces**
 - KCS interface hardware can be used to implement an ACPI EC (Embedded Controller) interface
 - Additional interface can support OEM differentiation access, such as from an SMI Handler

BMC Features to look for...

I²C/SMBus Support

- **Recommend three Master-Slave interfaces for general purpose server BMC:**
 - 5V Master-slave for IPMB
 - 3.3V Master-slave for PCI Mgmt. Bus
 - 5V for Redundant IPMB in modular/blade server applications or M/S interface for LAN / Future
- **Supports multiple slave addresses**
 - One fixed for I²C broadcast (00h)
 - One programmable for device as IPMI target
 - Second programmable for snoop/SMBus host target
- **SMBus and I²C compatibility**
 - For PCI SMBus support and sensor device flexibility

BMC Features to look for...

I²C/SMBus Support

Multiple private management bus support

- Reduces need for external I²C bus multiplexing
- Hardware-based m/s or slave-only hardware-based interfaces are best
 - Important for LAN Controller interface performance
- ‘Open drain’ or ‘quasi- bi-directional’ I/O can be used to create ‘bit banded’ private busses
 - Mainly useful for sensor devices that do not require extensive polling

Flexible I/O

- **Selectable open-drain or driven outputs**
 - Reduces need for external pullups
 - Can implement 'bit banded' private I²C/SMBus
- **3.3V Standby operation with 5V tolerance**
 - 5V tolerance on I²C reduces cost of IPMB support
 - Supports 5V status and SEEPROMs (e.g. Power Supply FRU)
- **High current outputs (>12 mA)**
 - For direct LED drive

BMC Features to look for...

UARTs and Interrupts

- **UARTs with hardware handshake support**
 - For ICMB & IPMI-over-Modem support
- **Multiple UARTs**
 - To support redundant connections for modular server designs
- **Multiple External Interrupts**
 - For asynchronous event capture

BMC Features to look for...

FAN monitoring & control

- **Timers or Counters for Tach FAN Speed monitoring**
 - Tach FAN speed can be accumulated using a single counter with a digital multiplexer
 - FAN speed is calculated by accumulating counts per unit time, e.g. 1 second.
 - Time to accumulate FAN speeds scales with number of FANs. I.e. monitoring 8 fans takes 8 seconds.
- **Pulse-width Modulator (PWM) or D/A outputs for FAN Speed control**

BMC Features to look for...

Built-in Analog-to-Digital

- **Need for at least 7 voltages is common**
 - E.g. Processor 1 & 2, 3.3V, 3.3Vaux, 5V, 12V, -12V
- **Many server systems require more**
 - >2 processors, SCSI terminations, bus, cache/chipset, etc.
 - 19 or more is not uncommon!
- **Conversion rate usually not an issue...**
 - A single converter with analog multiplexing works well
- **But accuracy, tolerance, and resolution are**
 - Recommend at least 8-bit resolution, +/-1 bit tolerance, and +/-1% accuracy

Low accuracy paid for with system margins

BMC Features to look for...

Firmware support

- **Development and Debug Support**
 - Vendor-provided debug tools
 - Test port or emulator support
 - Commercial high-level language & code debugging tools
 - Commercial RTOS options
- **IPMI Firmware / SDK**
 - Typical SDKs support customer-developed extensions for 'Value added' features
 - Vendors may also offer customization services

Firmware and SDKs yield faster TTM for IPMI-based designs

BMC Features to look for...

Extensibility, Headroom, and Low Cost

- **Low Power Consumption**
 - <50 mA is a pretty good target
- **Scalability**
 - Can one controller fit multiple products?
 - ...Or is it part of a 'family' that can?
- **ROM/RAM Upgrade Path**
- **Performance Headroom**
 - Authentication & Encryption for potential future interfaces, e.g. Web, demands compute power
- **External Expansion Capability**
- **Package and Board Space**
 - BGA packaging can provide higher density
 - Watch tradeoffs between package size & overall solution cost
- **Low Unit Cost**

Management Controllers*

 = new since last presentation

Mfr.	product	core	system I/F	I ² C	A/D	serial	type	App	LED drv	special features	IPMI F/W	Avail.
Agilent	eRMC	Contact vendor...										
Dallas Semi.	DS80CH11	8032 compat.	3 KCS via ISA	2 m/s	Y	1	8051	BMC			no	now
Hitachi	H8/3337Y	H8 8-bit	1 KCS via ISA	1 m/s	Y	Y	SCI	BMC		D/A, PWM	no	now
	H8S/2148	H8S 16-bit	4 KCS via ISA	2 m/s	Y	Y	SCI	BMC		D/A, PWM	no	now
National Semi.	87431	mini BMC										
Philips	80C652	8032 compat.	external req'd	1 m/s	no	1	8051	Sat / Bridge			no	now
	80C552	8032 compat.	external req'd	1 m/s	8 ch	1	8051	Sat / BMC			no	now
Qlogic	Zircon BL	ARM7/ TDMI	2 KCS via LPC	2 m/s	6**	1	"16550"	BMC	yes	2 PWM, 2 fan tach, USP,	yes	4Q02
Qlogic	Zircon UL	ARM7/ TDMI	2 KCS via LPC	2 m/s	6**	1	"16550"	BMC	yes	3 PWM, 4 fan tach, USP,	yes	4Q02

** Comparators

... Continued next page

Management Controllers*

Mfr.	product	core	system I/F	I ² C	A/D	serial	type	App	LED drv	special features	IPMI F/W	Avail.
Qlogic	Zircon CP 128 QFP	ARM7/ TDMI	BT, 2 KCS LPC/ISA	2 m/s	6 ch	1	same	BMC / cPCI	yes	2 PWM, 4 fan tach	yes	now
Qlogic	Zircon	ARM7/ TDMI	3 KCS via LPC, ISA	3 m/s	10 ch	2	"16550"	BMC	yes	8 PWM, ICMB assist, 12 fan tach	yes	now
Qlogic	Zircon Lite 160 PQFP	ARM7/ TDMI	BT, 2 KCS LPC/ISA	2 m/s	8 ch	1	same	BMC / cPCI	yes	2 PWM, 4 fan tach	yes	now
Vitesse Semi.	VSC210	R3000	3 KCS/ SMIC/ BT via LPC	3 m/s	no	3	ICE/GP FIFO'd ICMB	BMC / Sat	12mA	fan tach, ICMB assist	yes	now
Vitesse Semi.	VSC215	R3000	3 KCS/ SMIC/ BT via LPC	4 m/s	Y	4	ICE/GP FIFO'd ICMB	BMC / Sat	12mA	fan tach, ICMB assist	yes	now
Winbond	W83910F	8032 compat.	3 KCS/ SMIC/ BT via LPC	5 m/s	7	2	"16550"	BMC	yes	PWM, LCD Module I/F, 4 temp diode	yes	now

Baseboard Management Controllers

Qlogic* Zircon UL

- Target applications: 1P/2P Servers
- 32 GPIO (max), 4 Fan tach, 3 PWM
- 128-pin PQFP
- Virtual Storage Interface – supports ‘virtual floppy’
- Universal Serial Interface
 - for serial redirection / headless
- Samples: now, Production: 4Q02

Qlogic Zircon BL

- Target applications: server blades, high-end workstations
- 18 GPIO (max), 2 fan tach, 2 PWM
- 100-pin PQFP
- Virtual Storage Interface
- Universal Serial Interface
- Samples: now, Production: 4Q02



* Other names and brands may be claimed as the property of others.
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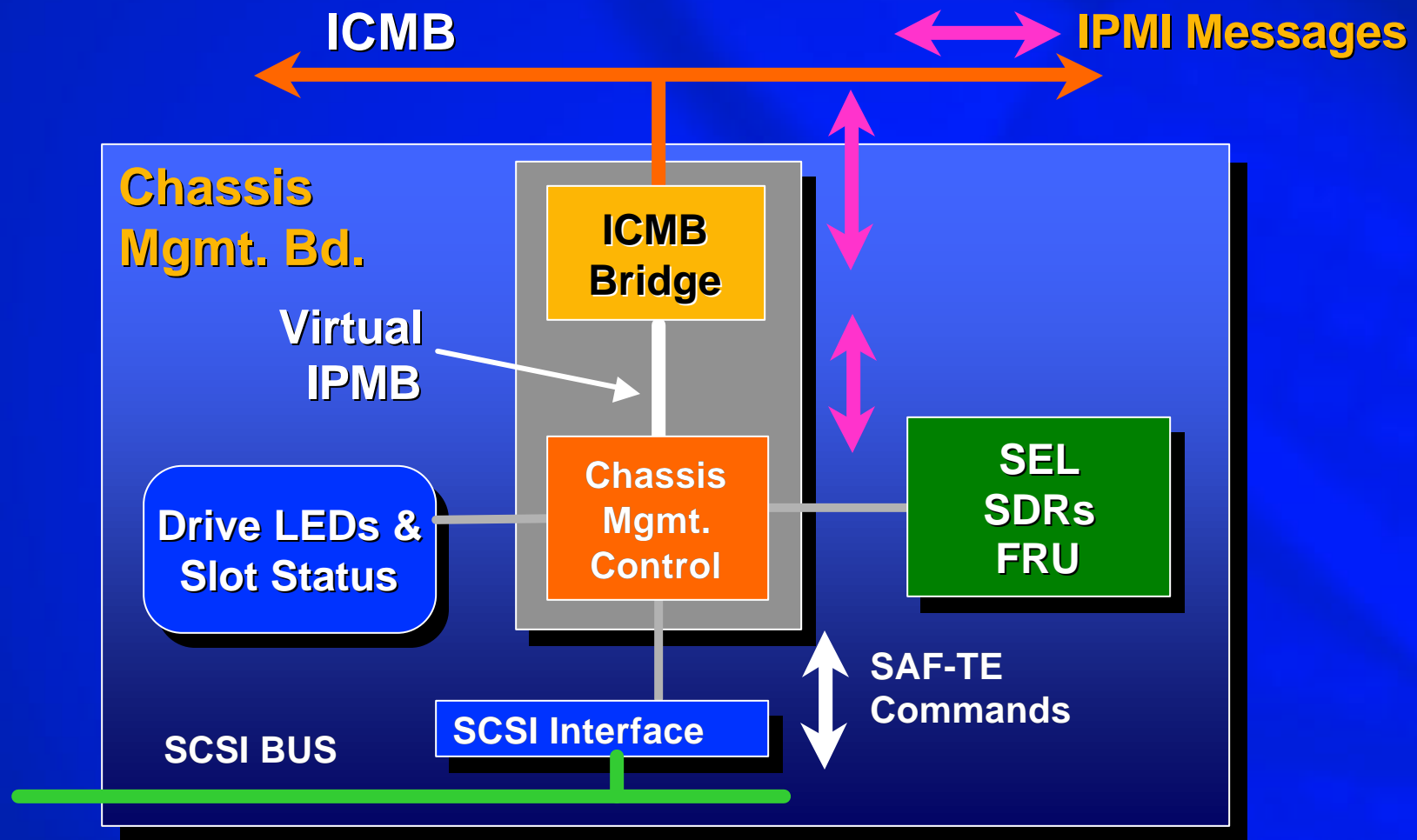


Baseboard Management Controllers

National Semiconductor* PC87431M “mini-BMC”

- **Targets IPMI-based LAN remote mgmt.**
 - supports monitoring by local mgmt. s/w via SMBus
 - configurable polling of sensors similar to ASF
- **Authenticated IPMI LAN support for:**
 - System reset, SMI/NMI, and power control
 - settable ‘Boot Options’
 - FRU, System Event Log, and SDR access
 - Alerting via IPMI/PET SNMP Traps
- **“PEF-like” configurable actions on events**
 - power control, reset, fault light, NMI/SMI, and alert
- **Internal FLASH, RAM, NVRAM**
 - up to 512 bytes NV available for OEM use

Example Block Diagram



- SAF-TE = SCSI Accessed Fault-Tolerant Enclosures
- SES = ANSI SCSI Enclosure Services

Features to look for...

- **SAF-TE and SES Firmware**
 - Extensible / customizable?
 - Configurable LED definitions?
- **IPMI Firmware / SDK**
 - IPMB Support?
- **Support for external sensors or FRU devices**
 - e.g. FAN & power monitoring

**Firmware and SDKs yield faster TTM
for Enclosure/Peripheral Controllers**

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Sensors and Monitors with I²C/SMBus

- **Board Temperature Sensors**
 - Temperature sensor in package
 - May include digital outputs for fan control
- **Processor Temperature Sensors**
 - Thermal diode monitors plus built-in temperature
 - May include automatic fan control
- **Hardware Monitors**
 - Voltages for board and processors
 - Processor VID (voltage ID) monitor
 - Temperatures
 - built-in plus remote thermal diodes for processors
 - Fan speeds
 - Digital I/O or PWM for fan speed control

Focus on dual-processor monitoring

Sensors and Monitors with I²C/SMBus

- **Other composite sensor devices**
 - Focus on specific areas
 - Disk drive enclosure monitoring
 - Fan monitoring & control and voltage monitoring for processors
 - Fan and voltage monitoring for >2-way systems
 - See examples in backup slides
- **Sensor Trend: Automatic Fan Control**
 - Noise Reduction becomes more difficult for pedestal servers
 - Need to meet PC Design Guide recommendations and European specs such as “Blue Angel”
 - Need for more granular / gradual speed control
 - Audible FAN Speed Cycling disconcerting to user
 - Need for per-fan or per-zone control
 - Driving all fans to same speed usually produces higher than needed noise level

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Design Pointers

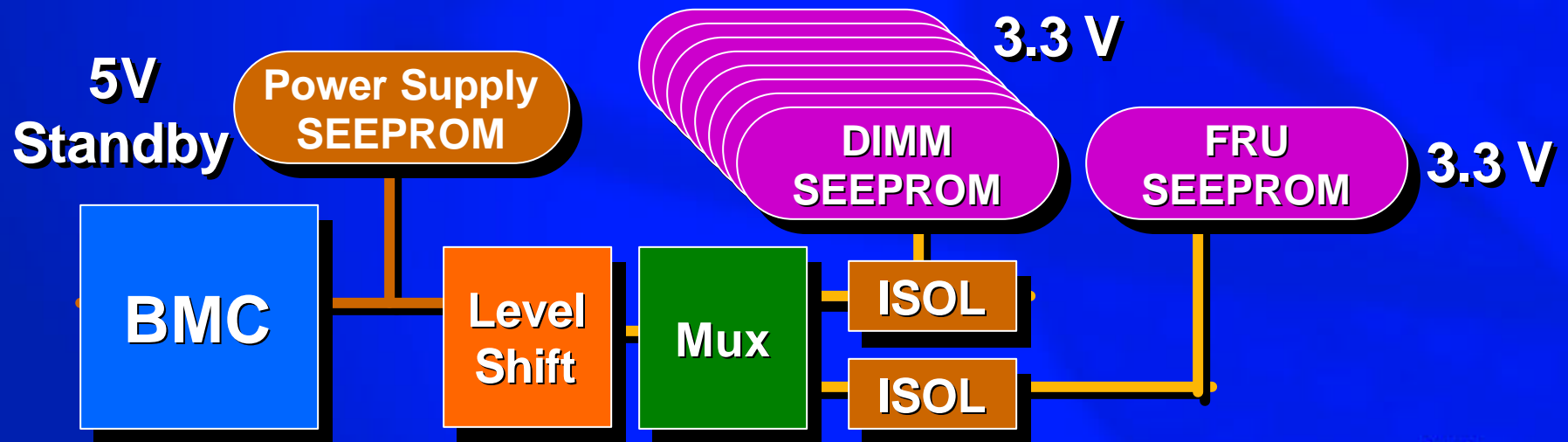
- **SMBus and I²C not directly compatible**
 - Timing and Electricals are close, but not identical
 - But masters and slave devices can be designed to work with both
 - And I²C and SMBus slave devices can typically be used on same bus
- **Slave Devices: Only use devices with data integrity checks on IPMB and PCI SMBus**
 - Place other devices on 'Private Management Busses' behind management controllers or other integrity-checked device
- **Masters: Include support for clearing the 'Stuck 0' condition**

Design for SMBus and I²C compatibility

See IPMI Web Site for more info

Bus Driving

- **Multiplexing** required when dealing with address option shortages or conflicts
- **Conversion** required when dealing with different bus voltage levels
- **Isolation** required when unpowered devices would 'short out' bus
- **Repeater** functionality when driving long busses or many loads (e.g. PCI SMBus)



Bus Driving

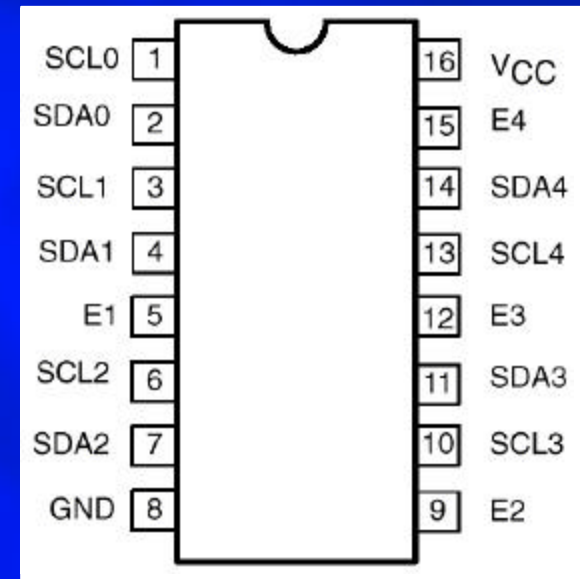
Philips Semiconductor* PCA9516 “5 channel I²C Hub”

- Allows *multiple* additional 400 pF bus segments
- Segments can be individually isolated
- Supports level translation (5V tolerant pins)
- Pins “Hi-Z” when device un-powered.
- Supports multi-master arbitration across the repeater

Possible applications:

Supporting PCI Management Bus on >8 PCI Slots, isolating SMBus to ‘hot-plug PCI’ slots, driving I²C to multiple system boards

PCA9515 single segment I²C Bus Repeater also available



Testers & Monitors

- **Generators and monitors available**
 - Standalone and PC Hosted
 - Ready to run software
 - Software libraries and SDKs enable IPMI message parsing
- **Some tool vendors our developers have used**
 - Microcomputer Control Corporation
<http://www.mcc-us.com/>
 - Calibre UK Ltd
<http://www.calibreuk.com/>
 - Card also supported in IPMI conformance test suite
 - Telos EDV Systementwicklung GmbH
<http://www.lucit.de/>

IPMI Messaging Testing

- **IPMITOOL**
 - simple messaging utility available from IPMI Web Site
- **Debug tools from component vendors**
- **Software from I²C tester vendors**
 - use SDKs to extend tool for IPMI message parsing
- **IPMI Conformance Test**

IPMI Conformance Test

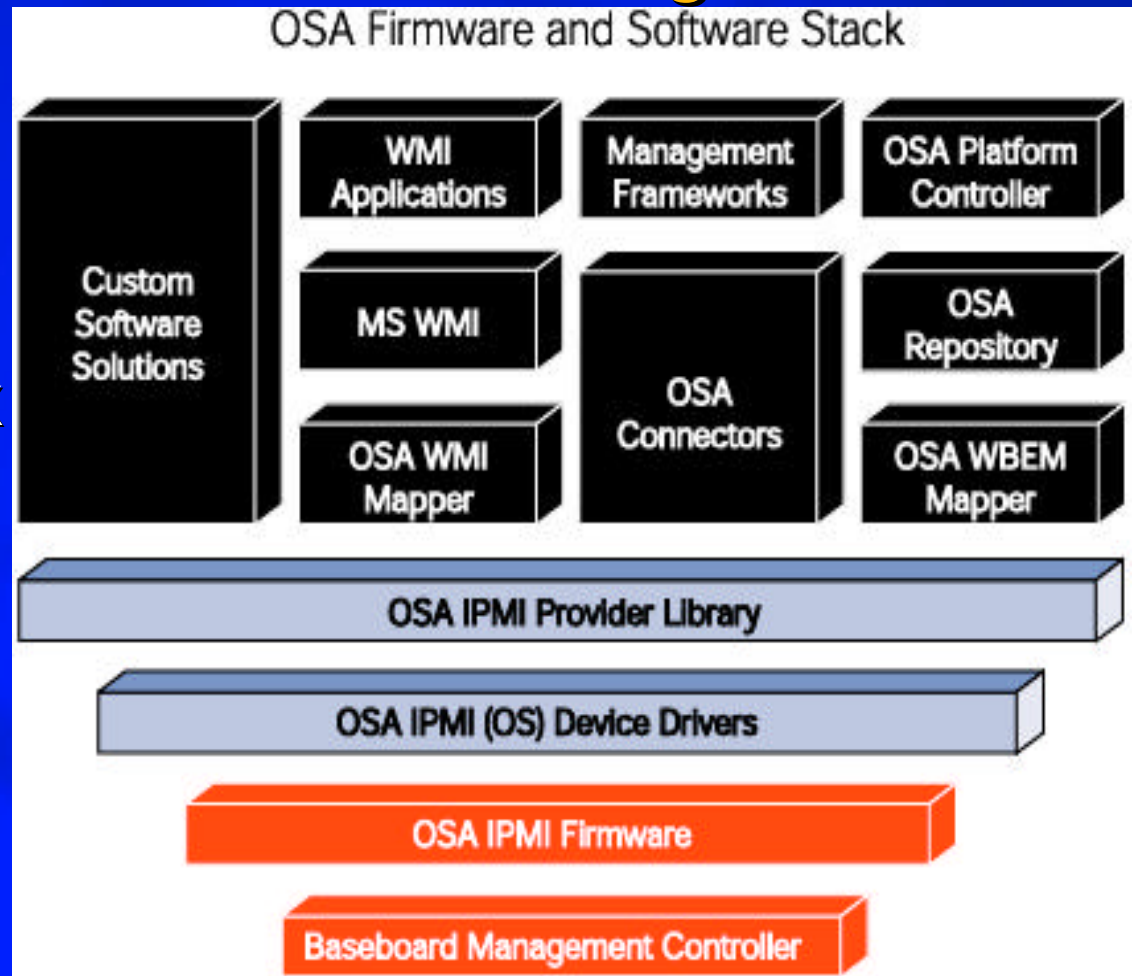
- **Automated testing for IPMI v1.5 & v1.0**
 - generates command conformance reports
- **Performs System interface accessible testing**
 - KCS and SMIC interfaces, Watchdog Timer, BMC Sensors
 - System event log (SEL), sensor data record (SDR), and FRU access
 - IPMB, ICMB testing
- **KCS protocol test**
- **IPMI v1.5 LAN, Serial, IPMB, and PCI SMBus test support**
- **Platform Event Filtering (PEF) and alerting**
- **Also usable as debug and development aid**
 - TCL script-based testing is user extensible
 - Examples provided

Speeds development and conformance testing

Software and Firmware building blocks

OSA Technologies

- Platform Mgmt. S/W and F/W for IPMI & PICMG 3.x
- Modular Architecture
 - Extensible
 - Scaleable across product lines



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Summary

- **New initiatives and specifications enable competitive server management features**
- **Management controllers and sensor devices available to fit your design and feature differentiation needs**
- **Tests & tools reduce system cost and design effort**
- **Help available today...**

Component & Tool Vendors*

- **Agilent Technologies**
contact.tm.agilent.com/tmo/datasheets/English/PRMC_ERMC.html, Niki Haines,
niki_haines@agilent.com
- **Analog Devices, Inc.**
www.analog.com/pc & /temp-sensors, Paul Errico - paul.errico@analog.com
- **Dallas Semiconductor**
www.dalsemi.com
- **Hitachi Semiconductor (America), Inc.**
semiconductor.hitachi.com
- **Micro Computer Control Corporation**
www.mcc-us.com, Ed Thompson, ed.thompson@mcc-us.com
- **National Semiconductor Corporation**
www.national.com/appinfo/tempsensors/ & /advancedio, Hezi Friedman,
hezi.friedman@nsc.com
- **Philips Semiconductors**
www.philipslogic.com/products/i2c, Joe Kochanski, joseph.kochanski@phlips.com
- **OSA Technologies**
www.osatechnologies.com, Steve Rokov, steve.rokov@osatechnologies.com
- **Qlogic Corporation**
www.qlogic.com, Mark Byrne-Quinn, mark.byrne-quinn@qlogic.com
- **Texas Instruments**
www.ti.com
- **Vitesse Semiconductor Corporation**
www.vitesse.com, Tom Brokaw, brokaw@vitesse.com
- **Winbond Electronics Corporation**
www.winbond.com.tw, Chad M.C. Wu, mcmwu@winbond.com.tw

Organizations / Specifications

- **IPMI (Intelligent Platform Management Interface) Specifications**
 - <http://developer.intel.com/design/servers/ipmi>
- **SMBus Specifications**
 - System Management Bus (SMBus) Specification, Version 2.0, August 3, 2000
<http://www.smbus.org>
- **I²C Specifications**
 - The I²C-BUS Specification, Version 2.1, January 2000
<http://semiconductors.philips.com/>
- **DMTF Pre-OS Working Group / ASF Specifications***
 - <http://www.dmtf.org>
- **PICMG / AdvancedTCA – PCI Industrial Computers Working Group**
 - <http://www.picmg.org>

IPMI Promoters, Adopters and Contributors

- ABIT Computer Corp.
- Acer Inc.
- Advanced Micro Devices, Inc.
- Agilent Technologies GmbH
- Alberta Microelectronics
- Allion Computer Inc.
- American Megatrends Inc.
- Arima Computer Corp.
- ASIS LTD.
- ASUSTek Computer, Inc.
- Avian Communications
- Axil Computer, Inc.
- Blue Wave Systems
- Bull S.A.
- Celestica
- C&D Technologies, Inc.
- ColoWATCH, Inc.
- Communication Automation Corporation
- Concurrent Technologies PLC
- CyberGuard Corporation
- Cyclades Corporation
- Data General Corporation
- Decru, Inc.
- Dell Computer Corporation
- Egenera, Inc.
- ElanVital Corporation
- Ericsson UAB
- Evans & Sutherland
- Eversys Corporation
- Exabyte Corporation
- First International Computer, Inc.
- Flextel SpA
- FORCE Computers GmbH
- Freedom Technologies Corporation
- Fujitsu, Ltd.
- GoAhead Software, Inc.
- HADCO Corporation
- HCL Infosystems Ltd.
- Hewlett-Packard Company
- Hewlett-Packard GmbH
- Hitachi Ltd.
- Hybricon Corporation
- I-Bus/Phoenix Corporation
- InnoMediaLogic, Inc.
- Intel Corporation
- Integra Micro Systems (P) Ltd.
- Interphase Corporation
- InterWorks Computer Products
- Inventec Corporation
- Ipex ITG
- JMC Products
- Kaparel Corporation
- L-3 Communications Corp.
- Legend (Beijing) Limited
- Linux NetworX, Inc.
- Lynux Works, Inc.
- Macrolink, Inc.
- Magnetek, Inc.
- Micro-Star International
- Mirapoint, Inc.
- MiTAC International Corp.
- Mitsubishi Electric Corp.
- Information Systems Engineering Center
- Motorola Computer Group
- National Semiconductor Corp.
- NEC Corporation
- Nematron Corporation
- Network Appliance, Inc.
- Network Engines, Inc.
- Network Storage Solutions, Inc.
- NOCpulse, Inc.
- Olivetti Computers Worldwide
- OSA Technologies
- PEP Modular Computers
- Performance Technologies, Inc.
- Phoenix Technologies Ltd.
- Pigeon Point Systems
- Pinnacle Data Systems, Inc.
- Praim, Inc.
- Qlogic Corporation
- Quanta Computer Inc.
- Radisys Corporation
- RAMIX Inc.
- Reliance Computer Corporation
- Samsung Electronics Co., LTD
- Sanera Systems, Inc.
- SANGate Systems, Inc.
- SBS Technologies, Inc.
- Scenix Semiconductor, Inc.
- Siemens AG
- Silicon Graphics, Inc.
- SKY Computers, Inc.
- Stan Cox & Associates
- Standard Microsystems Corporation
- StrataLight Communications, Inc.
- Stratus Computer Systems Ireland Ltd.
- Summit Microelectronics, Inc.
- Sun Microsystems
- Super Micro Computer, Inc.
- Symphony Group Intl. Co., Ltd.
- Synergy Microsystems
- Teknor Applicom, Inc.
- T-Netix, Inc.
- Tatung Co.
- Tektronix
- Texas Micro Corporation
- Toshiba Corporation
- Trimm Technologies
- Trilogic Systems, LLC
- Tyan Computer Corporation
- Universal Scientific Industrial Corp.
- USAR Systems, Inc.
- VIA Technologies, Inc.
- Vitesse Semiconductor Corp.
- Vividon, Inc.
- Vooha, Inc.
- Watrin System Design
- Winbond Electronics Corp.
- Wistron Corporation
- Ziatech Corporation
- ZNYX Networks, Inc.

Server Management Controllers, Sensors, and Tools

Tom Slaight
Intel Corporation



Questions?

**Please remember to turn in
your session survey form.**

**This presentation will be
posted September 26th**

<http://www.intel.com/idf>

**Attendee password will be sent two weeks
after the conference via email.**

Backup

Enclosure/Peripheral Controllers*

Mfr.	product	core	Periph. I/F	I ² C	A/D	serial	type	LED drv	special features	IPMI F/W	Avail.
QLogic	GEM 359	8-bit	LVDS, 2 SFF-8067	2 m/s		1	16550	4 @ 12mA	4 tach fan, 3 PWM	yes	now
Qlogic	Zircon PM	ARM7/ TDMI	n/a	3 m/s	6 ch			1 @ 12mA	2 PWM, 2 fan tach	yes	now
Vitesse Semi.	SSC100	R3000	Fibre Channel	3 m/s	N	2	ICE/GP FIFO'd ICMB	12mA	ICMB Arbitration	yes	now
Vitesse Semi.	VSC200	R3000	Fibre Channel, SFF-8067, ESI	3 m/s	N	2	ICE/GP FIFO'd ICMB	12mA	ICMB Arbitration	yes	now
Vitesse Semi.	VSC205	R3000	SCSI	3 m/s	N	2	ICE/GP FIFO'd ICMB	12mA	ICMB Arbitration	yes	now

Example Board Temperature Sensors*

		resol. bits	acc degC	addr.	dig. out	pins	
Analog Devices	AD7416	10	+/- 2		1	8	
	AD7417B	10	+/- 2		1	16	temp + 1ch A/D
	AD7418	10	+/- 3		1	8	temp + 4ch A/D
Dallas Semiconductor	DS75	9	+/- 2	8	1	8	
	DS1621	9	+/- 0.5	8	1	8	-25 to 100 +/- 2
	DS1624	13	+/- 0.5	8	0	8	temp + SEEPROM
	DS1721	9	+/- 1	mask	1	8	
	DS1775	9	+/- 2	8	1	SOT23-5	
National Semiconductor	LM75	9	+/- 3	8	1	8	-25 to 100 +/- 2
	LM77	9	+/- 3	4	2	8	10 to 65 +/- 1.5

Processor/ Remote Diode Temperature Sensors*

			Local	acc. degC	Remote Diode	acc. degC	pins	special
	Analog Devices	ADM1021	1	+/- 1	1	+/- 3	16	
	Analog Devices	ADM1028	1	+/- 2	2	+/- 3	16	FAN ctrl.
#	Maxim	MAX1617A	1	+/- 2	1	+/- 3	16	
#	National	LM83	1	+/-3	3	+/- 3	16	
#	National	LM84	1	+/- 1	1	+/- 3	16	
#	Philips	NE1617	1	+/- 2	1	+/- 3	16	
	Texas Instr.	THMC10	1	+/- 2.5	1	+/- 3	16	
	Texas Instr.	THMC50	1	+/- 3	1	+/- 3	16	FAN ctrl., 2 A/D

Pin Compatible

Hardware Monitors*

		volt.	temp.	fan	VID	chassis intr	POST RAM	add'l I/F	fan ctrl /special	pins	data sheet
Analog Devices	ADM9240	6	1 internal	2	1x5	1			Analog out	24	
	ADM1024	8	2 remt. diode, 1 internal	2	1x5	1			Analog out	24	prelim.
	ADM1025	5	1 remote diode, 1 internal	0	1x5	0				16	prelim.
Dallas Semiconductor	DS1780	6	1 internal	2	1x5	1			Analog out	24	
National Semiconductor	LM78/79	7	1 internal	3	1x4	1	yes	ISA		44	
	LM80	7	1 remt. sensor, 1 internal	2	0	1				24	
	LM81	6	1 internal	2	1x5	1			Analog out	24	
	LM87	8	2 remote diode, 1 internal	2	1x5	1			Analog out	24	
Philips Semiconductor	Heceta-IV *	5	1 remt. diode, 1 internal	0	1x5	0				16	prelim.
Winbond	W83781D	7	3 remt. diode	3	1x5	1		ISA	beep out	48	
	W83782D	9	3 remt. diode	2	1x5	1	yes	ISA	3 PWM, beep	48	prelim.
	W83783S	5	3 remt. diode	3	1x5	1			2 PWM, beep	24	
	W83L784R	5	2 remt. diode	2	1x5	1			FAN ctrl, beep	24	
	W83L785R	4	2 remt. diode	2	1x5	1			2 PWM, 9 GPIO	24	
	W83791D	9	3 remt. diode	2	1x5	1			FAN Ctrl & Speech	48	



* Other names and brands may be claimed as the property of others.

Miscellaneous Sensors and Actuators

Analog Devices* ADM1026

- 3 Channel $\pm 1^{\circ}\text{C}$ Temp Sensor
- 19 voltage channels
- 8 x Fan Control and Monitoring
- 16 GPIO
- 8k EEPROM
- 48LQFP

Analog Devices ADM1029

- 3 Ch. $\pm 1^{\circ}\text{C}$ Temp Sensor
- 2 voltage channels
- *Automatic Fan Control* and Monitoring
- Supports Fan Hot Swap
- 24 QSOP

Analog Devices ADM1031

- 2 x Automatic Fan Control and Monitoring
- Fan Fault and Therm Fault indications
- 16TSSOP

Vitesse Semiconductor* VSC055

I²C Enhanced Backplane Controller

- Designed as a companion component to enclosure management processors
 - I²C bus
 - 8 Fan-speed monitor inputs
 - 8 Programmable PWM outputs
 - 64 12mA, programmable, bi-directional I/O pins with individually selectable one of 7 LED flash rates
 - 32 GPIO pins can be used as FC-AL port bypass control pins
 - Programmable interrupt control for 64 interrupt sources (I/O, bypass input transitions, and fan speed thresholds)
 - 100-pin PQFP pkg.
- SSC050 is a subset of the VSC055 (e.g. 4 fans & PWM, 40 GPIO, 52 interrupt sources)*

Testers & Monitors

Microcomputer Control Corporation <http://www.mcc-us.com/>

- **MIIC-101K**
 - I²C/SMBus Standalone Monitor and Software Analyzer Kit
- **MIIC-102 I²C/SMBus Bus Monitor Plus**
 - I²C and SMBus 400 kbps monitoring
 - ISA, PCI, and PC Card interfaces available
- **MIIC-202 iPort/AI**
 - RS-232 to I²C Host Adapters with serial port ASCII Interface.
- **Software**
 - I²C/SMBus Software Analyzer Package
 - iPort Software Development Kit for Windows, Professional Edition

Calibre UK Ltd <http://www.calibreuk.com/>

- **ICA90/93LV PICA90/93LV**
 - ISA and PCI I²C-Bus adapters
- **desk-top (parallel port) I²C-Bus adapters**
- **Software**
 - ICADLL and PICADLL developers I²C-Bus windows programming libraries
 - WINI2C ready-to-run I²C-Bus software

Testers & Monitors

Telos EDV Systementwicklung GmbH

<http://www.lucit.de/>

TRACII

- **H/W based, 400 kbps I²C monitor/tracer**
 - Hardware and software filters for logged data
 - EPP parallel port interface
- **SDK supports adding protocol decode software**
- **Can inject as well as monitor**
 - Slow switching between master and slave operation limits use for management controller emulation, however

Intel **Developer** Forum Fall 2002